PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
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in its capacity as elected Office

Date of mailing (day/month/year) 15 March 2001 (15.03.01)	
International application No. PCT/GB00/02536	**Applicant's or agent's file reference** SJA/53278/006
International filing date (day/month/year) 30 June 2000 (30.06.00)	**Priority date** (day/month/year) 02 July 1999 (02.07.99)
Applicant MORRISSEY, Patrick, John et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

29 January 2001 (29.01.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35	Authorized officer Juan Cruz Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

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NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BOULT WADE TENNANT
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT
ROYAUME-UNI

Date of mailing (day/month/year) 12 juillet 2001 (12.07.01)	
Applicant's or agent's file reference SJA/53278/006	**IMPORTANT NOTIFICATION**
International application No. PCT/GB00/02536	**International filing date** (day/month/year) 30 juin 2000 (30.06.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
NATIONAL POWER PLC Windmill Hill Business Park Whitehill Way Swindon Wiltshire SN5 6PB United Kingdom	GB	GB
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[X] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address	State of Nationality	State of Residence
INNOGY TECHNOLOGY VENTURES LIMITED Windmill Hill Business Park Whitehill Way Swindon Wiltshire SN5 6PB United Kingdom	GB	GB
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:
The person in Box 1 has transferred the assignment to the person in Box 2.

4. A copy of this notification has been sent to:

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[X] the International Preliminary Examining Authority
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[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Lazar Joseph Panakal
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

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PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

To:

BOULT WADE TENNANT
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT
ROYAUME-UNI

NOTIFICATION OF THE RECORDING OF A CHANGE

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1. The following indications appeared on record concerning:

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Name and Address
INNOGY TECHNOLOGY VENTURES LIMITED
Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire SN5 6PB
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address
REGENESYS TECHNOLOGIES LIMITED
Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire SN5 6PB
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

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[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
Maria Victoria CORTIELLO
Telephone No.: (41-22) 338.83.38

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(71) Applicant *(for all designated States except US)*: NATIONAL POWER PLC [GB/GB]; Windmill Hill Business Park, Whitehill Way, Swindon, Wiltshire SN5 6PB (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: MORRISSEY, Patrick, John [IE/GB]; 70 Newtown Road, New Denham, Uxbridge UB9 4BD (GB). MITCHELL, Philip, John [GB/GB]; 1 Compton Close, Loughborough LE1 13SF (GB). MALE, Stewart, Ernest [GB/GB]; 68 Farm Close, East Grinstead, West Sussex RH19 3QG (GB).

(74) Agent: BOULT WADE TENNANT; Verulam Gardens, 70 Gray's Inn Road, London WC1X 8BT (GB).

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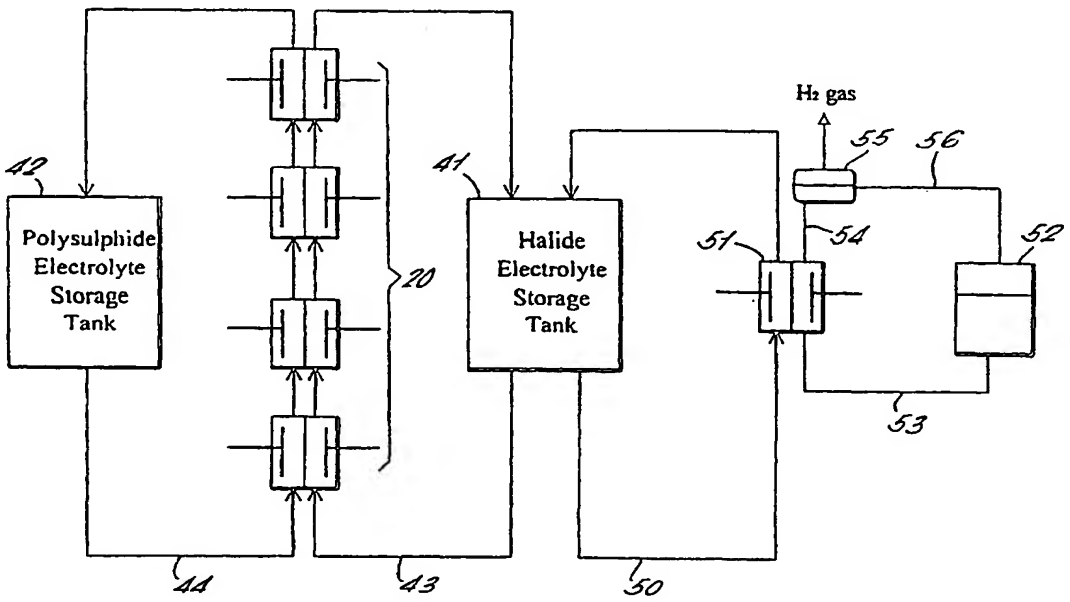

(57) Abstract: A process for rebalancing the electrolyte system in a regenerative fuel cell using a sulfide/polysulfide reaction in one half of the cell and a bromine/bromide reaction in the other half of the cell comprises passing the electrolyte containing sulfide/polysulfide or bromine/bromide through the $+^{ve}$ chamber of an auxiliary cell and passing an electrolyte containing water and being free from polysulfide or bromine through the $-^{ve}$ chamber of the auxiliary cell, the auxiliary cell operating so as to oxidise sulfide ions to sulfur or bromide ions to bromine in the $+^{ve}$ chamber and to reduce water to hydrogen and hydroxide ions in the $-^{ve}$ chamber.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Electrolyte Rebalancing System

The present invention relates to the field of regenerative fuel cell (RFC) technology. In particular it relates to apparatus and methods for the operation of RFCs which enhance their performance characteristics.

The manner in which RFCs are able to store and deliver electricity is well known to those skilled in the art. An example of an RFC is described in US-A-4485154 which discloses an electrically chargeable, anionically active, reduction-oxidation system using a sulfide/polysulfide reaction in one half of the cell and an iodine/iodide, chlorine/chloride or bromine/bromide reaction in the other half of the cell. The two halves of the cell are separated by a cation exchange membrane.

The overall chemical reaction involved, for example, for the bromine/bromide-sulfide/polysulfide system is shown in Equation 1 below:

$$Br_2 + S^{2-} \rightleftharpoons 2Br^- + S \qquad \text{Equation 1}$$

However, within an RFC such as that described in US-A-4485154, the reaction takes place in separate but dependent bromine and sulfur half-cell reactions as shown below in Equations 2 and 3:

$$Br_2 + 2e^- \rightleftharpoons 2Br^- \qquad \text{Equation 2}$$

$$S^{2-} \rightleftharpoons 2e^- + S \qquad \text{Equation 3}$$

It should be noted however that these equations represent the overall reactive changes occurring in the RFC. In practice the reactions are complicated by

the low basicity of sulfide which results in the formation of bisulfide as the active species, as shown in Equation 4.

$$S^{2-} + H_2O \rightleftharpoons HS^- + OH^- \qquad \text{Equation 4}$$

Also, the sulfur produced in Equations 1 and 3 forms soluble polysulfide species in the presence of sulfide ions, as shown in Equation 5 (where x may be from 1 to 4).

$$S^{2-} + xS \rightleftharpoons S_{x+1}^{2-} \qquad \text{Equation 5}$$

Also, free bromine is solubilised in the presence of bromide ions to form the tribromide ion, as shown in Equation 6

$$Br^- + Br_2 \rightleftharpoons Br_3^- \qquad \text{Equation 6}$$

When the RFC is discharging, bromine is converted to bromide on the $+^{ve}$ side of the membrane and sulfide is converted to polysulfide on the $-^{ve}$ side of the membrane. Equation 1 goes from left to right and metal ions flow from the $-^{ve}$ side of the membrane to the $+^{ve}$ side of the membrane to complete the circuit. When the RFC is charging, bromide is converted to bromine on the $+^{ve}$ side of the membrane and polysulfide is converted to sulfide on the $-^{ve}$ side of the membrane. Equation 1 goes from right to left and metal ions flow from the $+^{ve}$ side of the membrane to the $-^{ve}$ side of the membrane to complete the circuit.

The discharge/charge cycle described above will be repeated many times during the lifetime of the RFC and in order for the RFC to work efficiently throughout its lifetime it is important that the electrolytes remain balanced. In the context of the present

specification, when the term "balanced" is used to describe the electrolytes it means that the relative concentrations of the reactive species within the electrolytes are maintained at, or close to, values which enable optimum performance of the RFC. Similarly, in the context of the present specification, the term "rebalancing" refers to a process which alters the concentration of one or more reactive species in one or both of the electrolytes so as to return said electrolytes to a balanced state or so as to maintain said electrolytes in a balanced state.

At the beginning of the RFC's lifetime the relative concentrations of the reactive species on either side of the membrane will normally be fixed so that the electrolytes are balanced. However, once the RFC begins to operate in its repeating discharge-charge cycle, factors may intervene which result in the electrolytes becoming unbalanced. These factors will vary depending upon the identity of the reactive species within the electrolytes and on the manner in which the RFC is constructed and operated.

In the case of the bromine/bromide-sulfide/polysulfide RFC such as that described above, the most important factor which results in the electrolytes becoming unbalanced is the diffusion of unwanted species across the membrane. Although a cation selective ion-exchange membrane is used, 100% permselectivity is not possible and during extended cycling of the cell some anionic species diffuse through the membrane. In particular, sulfide ions (largely present in the bisulfide form, HS^-) and polysulfide ions (S_{x+1}^{2-}, where x may be from 1 to 4) may diffuse from the sulfide/polysulfide electrolyte into the bromine/bromide electrolyte where they will be

oxidised by the bromine to form sulfate ions as shown in equations 7 and 8 below:

$$HS^- + 4Br_2 + 4H_2O \rightarrow 8Br^- + SO_4^{2-} + 9H^+$$

Equation 7

$$S_{x+1}^{2-} + (3x+4)Br_2 + (4x+4)H_2O \rightarrow (6x+8)Br^- + (x+1)SO_4^{2-} + (8x+8)H^+$$

Equation 8

Imperfections other than diffusion through the membrane which could similarly contribute to the above process are ineffective sealing between cell compartments, or catastrophic failure of any of the cell separating components, each of which may result in crossover of the electrolytes between cell compartments.

In Equations 7 and 8, the oxidation of the sulfur species goes beyond that which occurs during normal operation of the RFC. That is to say, the sulfide and polysulfide ions are oxidised all the way to sulfate ions. Consequently, in the case of sulfide ion cross-over (Equation 7), four bromine molecules per sulfide ion are consumed rather than the normal one bromine molecule per sulfide ion which is consumed in the reaction scheme of Equation 1. Similar overconsumption of bromine results from polysulfide cross-over (Equation 8) although to a slightly lesser extent. As a result, the bromine/bromide electrolyte becomes discharged to a greater extent than the sulfide/polysulfide electrolyte. Thus, when the cell is discharging there is insufficient bromine present to react with all the sulfide ions present thereby

preventing completion of the discharge cycle. As a result, the voltage generated by the cell begins to decline earlier in the discharge cycle than when the electrolytes are balanced. In effect, the reactions represented by Equations 7 and 8 result in the conversion of some of the polysulfide ions to sulfide because not all of the polysulfide ions are recovered on discharge. Subsequent cycles repeat this process, further reducing the number of polysulfide ions present. Ultimately, there will be insufficient polysulfide ions present to accept charge during the charge cycle. Since the electrochemistry has to continue if charging is maintained, the next most favourable reaction occurs, i.e. water is reduced and the electrode on the $-^{ve}$ side of the cell starts to gas hydrogen.

It would therefore be advantageous to provide a process for rebalancing the electrolytes in order to compensate for the unbalancing effect of the crossover of sulfide and/or polysulfide electrolyte species into the bromine electrolyte. Although it would be possible to replace the electrolytes in the system with fresh electrolytes at periodic intervals, this is disadvantageous because of the economic implications and because of the environmental implications of the great amounts of waste electrolytes which would require to be disposed of.

Accordingly, the present invention provides an electrochemical process for energy storage and/or power delivery comprising:

(i) maintaining and circulating electrolyte flows in a fully liquid system in which the active constituents are fully soluble in a single cell or in an array of repeating cell structures, each cell with a positive ($+^{ve}$) chamber containing an

inert $+^{ve}$ electrode and a negative ($-^{ve}$) chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating in the $-^{ve}$ chamber of each cell during power delivery containing a sulfide (electrolyte 1), and the electrolyte circulating in the $+^{ve}$ chamber during power delivery containing bromine (electrolyte 2),

(ii) restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers by circulating the electrolyte from each chamber to storage means comprising a volume of electrolyte greater than the cell volume for extended delivery of power over a longer discharge cycle than the cell volume alone would permit, and

(iii) rebalancing the electrolytes by circulating a fraction of electrolyte 1 or electrolyte 2 through the $+^{ve}$ chamber of an auxiliary cell, said auxiliary cell comprising a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell containing water and being free from polysulfide and free from bromine during rebalancing, the auxiliary cell operating so as to oxidise sulfide ions to sulfur or bromide ions to bromine in the $+^{ve}$ chamber and so as to reduce water to hydrogen and hydroxide ions in the $-^{ve}$ chamber.

The oxidation of bromide to bromine rebalances the electrolytes by restoring the bromine which is reduced by reaction with migrating sulfide ions. Oxidation of bromide to bromine may also be thought of as charging

the bromine/bromide electrolyte since the chemical content of the bromine/bromide electrolyte changes in the same manner as when the RFC is in its charging cycle.

The oxidation of sulfide to sulfur rebalances the electrolytes by oxidising the equivalent amount of sulfide which would ordinarily have been oxidised by the halogen which was reduced by reaction with migrating sulfide ions. Oxidation of polysulfide to sulfur may also be thought of as discharging the sulfide/polysulfide electrolyte since the chemical content of the sulfide/polysulfide electrolyte changes in the same manner as in the RFC when it is in its discharging cycle.

In order that rebalancing of the electrolytes may occur, it is essential that during the rebalancing process the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell should be free from polysulfide and free from bromine. The reason for this is that these chemical species are more readily reduced than water. If electrolyte 1 is circulated through the $+^{ve}$ chamber of the auxiliary cell and the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell contains polysulfide, then the reaction which will occur in the $-^{ve}$ chamber will be reduction of polysulfide to sulfide rather than reduction of water to hydrogen and hydroxide ions. This would result in no net change in the oxidation state of the sulfur species present in the system. If reduction of water is to occur in the presence of polysulfide the $-^{ve}$ electrode in the $-^{ve}$ chamber must be specially constructed to starve it of polysulfide. Similarly, if electrolyte 2 is circulated through the $+^{ve}$ chamber of the auxiliary cell and the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell contains

bromine, then the reaction which will occur in the $-^{ve}$ chamber will be reduction of bromine to bromide rather than reduction of water to hydrogen and hydroxide ions. This would result in no net change in the oxidation state of the bromine species present in the system. If reduction of water is to occur in the presence of bromine the $-^{ve}$ electrode in the $-^{ve}$ chamber must be specially constructed to starve it of bromine. Inclusion of such specially constructed electrodes is clearly undesirable from an economic and system maintenance viewpoint.

The rebalancing process may be applied continuously to the RFC wherein a sidestream of the bromine/bromide or sulfide/polysulfide electrolyte drawn from the mainstream is diverted through apparatus suitable for carrying out the rebalancing process. The rebalancing process may also be applied as a batch process wherein the fraction of the bromine/bromide or sulfide/polysulfide electrolyte which is removed from the RFC is treated in separate apparatus suitable for carrying out the rebalancing process before being returned to the RFC.

It will be understood by those skilled in the art that a number of reduction half-cell reactions may be used to counter the oxidation of the halide or sulfide. However, in the present invention, the other half-cell reaction under alkaline conditions involves the reduction of water to hydrogen and hydroxide ions according to the half-cell reaction shown in Equation 8 below:

$$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^- \qquad \text{Equation 8}$$

Thus the rebalancing process may be represented by the reactions shown in Equations 9 and 10 below:

$$2Br^- + 2H_2O \rightleftharpoons Br_2 + H_2 + 2OH^- \qquad \text{Equation 9}$$

$$S^{2-} + 2H_2O \rightleftharpoons S + H_2 + 2OH^- \qquad \text{Equation 10}$$

Similarly in an acidic medium the half cell reaction comprises

$$2H^+ + 2e^- \rightleftharpoons H_2 \qquad \text{Equation 11}$$

It will be appreciated that, although the process of oxidising the bromine/bromide or sulfide/polysulfide electrolyte can be used to rebalance the electrolytes, there is still a net loss of active sulfur species from the cell. This is because the sulfide and polysulfide ions which cross to the bromine electrolyte and are oxidised to sulfate ions are not recovered. Thus, in a preferred embodiment of the present invention, the process additionally comprises adding elemental sulfur or a sulfide salt to the sulfide/polysulfide electrolyte in an amount such as to restore the initial concentration of active sulfur species.

In carrying out the process of the present invention the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell may be water. In this instance the electrolyte will generally circulate in a closed system and there will be no change of pH of the bromine/bromide or sulfide/polysulfide electrolyte.

In an alternative manner of carrying out the process of the present invention the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell is a fraction of electrolyte 1 or 2 which has been made free of polysulfide or bromine by electrochemical reduction thereof. This may be achieved by recirculating electrolyte 1 or 2 through the $-^{ve}$

chamber of the auxiliary cell until all of the polysulfide or bromine has been reduced. The electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell may then be returned to the main stream of electrolyte 1 or 2.

Alternatively, the electrochemical reduction of polysulfide or bromine which may be present in electrolyte 1 or 2 respectively occurs within the $-^{ve}$ chamber of a second auxiliary cell which comprises a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating through the $+^{ve}$ chamber being a fraction of electrolyte 1 or electrolyte 2. This may be achieved by recirculating electrolyte 1 or 2 through the $-^{ve}$ chamber of the second auxiliary cell until all of the polysulfide or bromine has been reduced. The electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell may then be returned to the main stream of electrolyte 1 or 2.

Another reason why the reduction of any bromine which may be present in electrolyte 2 is important is because, as described in WO-A-00/03448, carrying out the RFC process of the present invention results in the production of sulfate ions in the bromine/bromide electrolyte as described above with reference to Equation 7. The removal of sulfate ions from the electrolyte can only be carried out by the process as described in WO-A-00/03448 in the absence of free bromine which otherwise interferes with the process. Thus, in a preferred embodiment, the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell during rebalancing is a fraction of electrolyte 2 and that fraction is subsequently treated to remove sulfate ions contained therein.

In carrying out the process of the present invention elemental sulfur and/or a sulfide salt may be added to the sulfide/polysulfide electrolyte in an amount sufficient to restore the initial concentration of sulfur species.

The present invention also provides for the use, in a process for energy storage and/or power delivery comprising:

(i) maintaining and circulating electrolyte flows in a fully liquid system in which the active constituents are fully soluble in a single cell or in an array of repeating cell structures, each cell with a positive ($+^{ve}$) chamber containing an inert $+^{ve}$ electrode and a negative ($-^{ve}$) chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating in the $-^{ve}$ chamber of each cell during power delivery containing a sulfide (electrolyte 1), and the electrolyte circulating in the $+^{ve}$ chamber during power delivery containing bromine (electrolyte 2),

(ii) restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers by circulating the electrolyte from each chamber to storage means comprising a volume of electrolyte greater than the cell volume for extended delivery of power over a longer discharge cycle than the cell volume alone would permit,

of a process comprising:

circulating a fraction of electrolyte 1 or electrolyte 2 through the $+^{ve}$ chamber of an auxiliary cell, said auxiliary cell comprising a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by

a cation exchange membrane, the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell containing water and being free from polysulfide and free from bromine during rebalancing, the auxiliary cell operating so as to oxidise sulfide ions to polysulfide or bromide ions to bromine in the $+^{ve}$ chamber and so as to reduce water to hydrogen and hydroxide ions in the $-^{ve}$ chamber,

for the purpose of rebalancing electrolytes 1 and 2.

The present invention also includes within its scope apparatus for carrying out a process as described above comprising:

(i) a single cell or an array of repeating cell structures, each cell comprising; a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode the chambers being separated from one another by an ion exchange membrane, an electrolyte circulating in the $-^{ve}$ chamber of each cell which contains a sulfide during power delivery (electrolyte 1), and an electrolyte circulating in the $+^{ve}$ chamber which contains bromine during power delivery (electrolyte 2),

(ii) storage and circulation means for each electrolyte for restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers,

(iii) means for rebalancing the electrolytes comprising an auxiliary cell which comprises a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode the chambers being separated from one another by a cation exchange membrane, means for circulating a fraction of electrolyte 1 or 2 through the $+^{ve}$ chamber of the auxiliary cell, an electrolyte containing water and being free from polysulfide

and free from bromine during rebalancing and means for circulating said electrolyte through the $-^{ve}$ chamber of the auxiliary cell.

The present invention will be further described with reference to the accompanying drawings in which:

Fig 1A is a schematic view of a basic electrochemical reduction-oxidation cell in which a sulfide/polysulfide reaction is carried out in one half of the cell and a bromine/bromide reaction is carried out in the other half of the cell;

Fig 1B is a diagram of cell arrays using the system of Fig 1A;

Fig 2 is a block diagram of a fluid flow system using the cell of Fig 1A;

Fig 3 is a flow diagram of an apparatus for carrying out a preferred embodiment of the process of the present invention.

Fig 4 is a flow diagram of an apparatus for carrying out a preferred embodiment of the process of the present invention.

Fig 5 is a schematic diagram of an apparatus for carrying out a further preferred embodiment of the process of the present invention, including the removal of sulfate.

Fig 6 is a flow diagram of an apparatus for carrying out a preferred embodiment of the process of the present invention, including the removal of sulfate.

Fig 7 is a graph of voltage versus time for a selected

number of cycles of a RFC which does not incorporate a rebalancing process in accordance with the present invention.

Fig 8 is a graph of voltage versus time for a selected number of cycles of a RFC which does incorporate a rebalancing process in accordance with the present invention.

Fig 1A shows a cell 10 with a positive ($+^{ve}$) electrode 12 and a negative ($-^{ve}$) electrode 14 and a cation exchange membrane 16 which may be formed from a fluorocarbon polymer with sulfonic acid functional groups to provide charge carriers. The membrane 16 acts to separate the $+^{ve}$ and $-^{ve}$ sides of the cell 10 and is selected to minimize migration of bromine from the $+^{ve}$ side to the $-^{ve}$ side and to minimize migration of sulfide and polysulfide ions from the $-^{ve}$ side to the $+^{ve}$ side. An aqueous solution 22 of NaBr is provided in a chamber 22C formed between the $+^{ve}$ electrode 12 and the membrane 16 and an aqueous solution 24 of Na_2S_x (where x may be from 2 to 5) is provided in a chamber 24C formed between the $-^{ve}$ electrode 14 and the membrane 16. A K_2S_x solution, which is more soluble and more expensive than the Na_2S_x solutions, is used in another embodiment.

When the cell is in the discharged state, a solution of NaBr of up to 6.0 molar concentration exists in the chamber 22C of the cell and a solution of Na_2S_x at 0.5 to 1.5 molar, exists in chamber 24C of the cell. Higher molarity is possible with K_2S_x.

As the cell is charged, Na^+ ions are transported through the cation membrane 16, as shown in Fig 1A, from the $+^{ve}$ to the $-^{ve}$ side of the cell. Free bromine is produced via oxidation of the bromide ions at the

$+^{ve}$ electrode and dissolves as a tribromide or pentabromide ion. Sulfur is reduced at the $-^{ve}$ electrode and the pentasulfide, Na_2S_x, salt eventually becomes the monosulfide as the charging proceeds to completion. At the $+^{ve}$ side the following reaction occurs,

$$2Br^- \Rightarrow Br_2 + 2e^-$$

and at the $-^{ve}$ side the following reaction occurs,

$$S + 2e^- \Rightarrow S^{2-}.$$

The membrane separates the two electrolytes and prevents bulk mixing and also retards the migration of sulfide and polysulfide ions from the $-^{ve}$ side to the $+^{ve}$ side, and the migration of Br^- and Br_2 from the $+^{ve}$ to the $-^{ve}$ side. Diffusion of the sulfide and polysulfide ions across the membrane results in the electrolytes becoming unbalanced as described earlier.

When providing power, the cell is discharging. During this action, reversible reactions occur at the two electrodes. At the $+^{ve}$ side electrode 12, bromine is reduced to Br^-, and at the $-^{ve}$ electrode, the S^{2-} ion is oxidized to molecular S. The electrons produced at the $-^{ve}$ electrode form the current through a load. The chemical reaction at the $+^{ve}$ electrode produces 1.06 to 1.09 volts and the chemical reaction at the $-^{ve}$ electrode produces 0.48 to 0.52 volts. The combined chemical reactions produce an open circuit voltage of 1.54 to 1.61 volts per cell.

The present system is an anionically active electrochemical system. Therefore, the cation which is associated with them essentially takes no part in the energy producing process. Hence, a cation of

"convenience" is chosen. Sodium or potassium are preferred choices. Sodium and potassium compounds are plentiful, they are inexpensive and have high water solubilities. Lithium and ammonium salts are also possibilities, but at higher costs.

Fig 1B shows an array 20 of multiple cells connected in electrical series and fluid parallel. Multiple mid-electrodes 13 (each one having a $+^{ve}$ electrode side 12A and $-^{ve}$ electrode side 14A) and end electrodes 12E ($+^{ve}$) and 14E ($-^{ve}$) are spaced out from each other by membranes 16 and screen or mesh spacers (22D, 24D) in all the cell chambers 22C, 24C, (portions of two of which 22D, 24D are shown by way of example) to form end cells C_{E1} and C_{E2} and an array of mid cells C_M (typically 10-20; but note much smaller and much higher numbers of cells can be accommodated). The end electrodes 12E ($+^{ve}$) and 14E ($-^{ve}$) have internal conductors 12F and 14F (typically copper screens) encapsulated therein and leading to external terminals 12G, 14G which are connected to external loads (e.g. to motor(s) via a control circuit (CONT), the motor(s) may be used to drive a vehicle) or power sources (e.g. utility power grid when used as a load-levelling device).

Fig 2 shows a free flow system, a power generation/storage system utilizing one or more of the batteries or cell array formats 20. Each cell 20 receives electrolyte through pumps 26 and 28 for the NaBr and Na_2S_x solutions (22 and 24, respectively). The electrolytes 22 and 24 are stored in containers 32 and 34. The tanks 32, 34 can be replaced with freshly charged electrolyte by substituting tanks containing fresh electrolyte and/or refilling them from charged supply sources via lines 32R, 34R with corresponding lines (not shown) provided for draining spent

(discharged) reagent. The electrolytes 22 and 24 are pumped from tanks 32 and 34, respectively, into the respective chambers 22C and 24C by means of pumps 26 and 28.

Fig 3 shows a free flow system in which an array of cells 20 are supplied with bromine/bromide and sulfide/polysulfide electrolyte from storage tanks 41 and 42 via lines 43 and 44. Bromine/bromide electrolyte may be removed from storage tank 41 via line 50 which transfers it to an external electrochemical cell 51 wherein the bromide is oxidised to bromine as a half-cell reaction in an electrochemical process. The other half-cell reaction involves the reduction of water to hydrogen and hydroxide ions. An aqueous electrolyte is stored in tank 52 and transported to the electrochemical cell 51 via line 53. The reduced electrolyte is passed via line 54 to tank 55 where hydrogen gas which is generated by the electrochemical reaction may be vented from the system. The electrolyte returns via line 56 to storage tank 52.

Fig 4 shows a particularly preferred variation of the free flow system illustrated in Fig 3. In this embodiment the aqueous electrolyte which is reduced in the external electrochemical cell 51 is also bromine/bromide electrolyte which has been removed from storage tank 41 to tank 52 via line 57. In this case, the reduction reaction will initially involve reduction of any residual bromine to bromide and will subsequently involve reduction of water to hydrogen and hydroxide ions. The reduced electrolyte may be subsequently returned to the storage tank 41 along line 58.

Referring to Fig 5, a schematic flow diagram is shown

of the manner in which the electrolyte may be treated. A storage tank 41 contains the aqueous bromine/bromide electrolyte which may be circulated around the main RFC system (not shown). The first treatment of a first stream of the electrolyte from tank 41 is to remove free bromine by treatment in an appropriate bromine reduction module 61 which comprises an auxiliary cell. The electrolyte is circulated via module 61 and an intermediate storage tank 62 until the bromine present in the electrolyte is reduced to bromide. When the reduction is complete the electrolyte is passed to storage tank 63. A second stream of the electrolyte from tank 41 is passed to an electrochemical cell module 64 where the bromide is oxidised to bromine as a half-cell reaction in an electrochemical process. The other half-cell reaction involves the reduction of water to hydrogen and hydroxyl ions using as the electrolyte for the hydroxyl ion production the electrolyte from storage tank 63. The stream of electrolyte passing through module 64 in which bromide has been oxidised to bromide is returned to the storage tank 41. The stream of electrolyte used in the complementary half-cell reaction may be passed to a further tank 65 where it is then subjected to a sulfate removal treatment according to the teaching of WO-A-00/03448 in module 66. The stream of electrolyte from which the sulfate has been removed is then returned to the original storage tank 41. Storage tank 63 is provided with appropriate means to vent hydrogen produced in the water reduction reaction to a hydrogen stack along line 67.

Fig 6 shows an alternative system for use in accordance with the present invention which includes a sulfate crystallization unit as described in WO-A-00/03448. In this system a portion of bromide/bromine

electrolyte contaminated with sulfate ions is drawn from the main system 80 via line 81 and held in a receiving tank 82. This electrolyte is then circulated via lines 83 and 84 through the $-^{ve}$ chamber 85 of an auxiliary cell 86 until substantially all of the bromine present in the electrolyte has been reduced to bromide ions. The voltage applied across cell 86 is limited to ensure that reduction of water does not occur. When the current density has run down (thus indicating that the conversion of bromine to bromide is substantially complete), the voltage applied to the cell 86 is increased to a value sufficient to cause reduction of the water present in the electrolyte so as to generate H_2 gas and OH^- ions. The electrolyte circulating through the $+^{ve}$ chamber of the external auxiliary cell is either sulfide/polysulfide or bromine/bromide electrolyte taken from the main system. The oxidation of one or the other of these electrolytes rebalances the system. The removal of water from the electrolyte is advantageous because it further increases the concentration of bromide ions thereby reducing the sulfate solubility and increasing the yield of sulfate on crystallisation. A tap 87 is provided to draw off H_2 gas. When sufficient rebalancing has occurred, the electrolyte circulating through the $-^{ve}$ chamber 85 is passed from the receiving tank 82 to the crystalliser 88 via line 89. This electrolyte is then passed via line 90 through a filter 91 to remove the sulfate crystals and then it may be returned to the main system via line 92. The embodiment shown in Fig 6 shows an electrolyte being drawn from the main system via line 93, passing through the $+^{ve}$ chamber 94 of the auxiliary cell and returning the main system via line 95.

The present invention will now be further described by

reference to the following examples.

Comparative Example 1

A regenerative fuel cell of the type described above having sulfide/polysulfide and bromine/bromide electrolytes was set up. The cell had the following specifications:

electrode material:	polyethylene impregnated with activated carbon
electrode area:	2000cm^2
current density:	80mA/cm^2
electrolyte volume:	9l per electrolyte
cycle time:	6hours (i.e. 3hours charge and 3hours discharge)
flow rate:	1000ml/min
membrane material:	Nafion 115™

The cell was operated over 18 cycles (108 hours) and the cell voltage was monitored throughout this period. The results are shown in Fig 7. It can be seen that after a limited number of cycles (about 7) the cell voltage limits early on the discharge cycle due to the lack of bromine. This problem gets worse as the number of cycles increases. It can be clearly seen on the graph that after about 12 cycles (72 hours) the cell fails to maintain a good voltage performance over the whole of the 3 hour discharge cycle.

Example 1

An identical RFC to that used in Comparative Example 1 was set up. This time the electrolytes were continuously rebalanced by oxidation of a sidestream of the bromide/bromine electrolyte drawn from the mainstream. Oxidation occurred in one half of an external electrochemical cell wherein the electrolyte

undergoing reduction in the other half of the cell was dilute aqueous sodium hydroxide. The external electrochemical cell used was an MP cell from Electrocell AB having the following specifications:

anode material:	platinum
cathode material:	nickel
electrode area:	100cm^2
current density:	13mA/cm^2
flow rate:	270ml/min
membrane material:	Nafion 350™

Fig.3 shows a schematic representation of the apparatus used in the present example. The cell was operated over at least 92 cycles (552 hours) and the cell voltage was monitored throughout this period. The results from the period from 400 to 550 hours are shown in Fig 8. It can be seen that even after 91 cycles (546 hours) the cell voltage does not limit early on the discharge cycle as occurred in the unbalanced cell. The cell retains a good voltage performance over the whole of the 3 hour discharge cycle.

CLAIMS:

1. An electrochemical process for energy storage and/or power delivery comprising:

(i) maintaining and circulating electrolyte flows in a fully liquid system in which the active constituents are fully soluble in a single cell or in an array of repeating cell structures, each cell with a positive ($+^{ve}$) chamber containing an inert $+^{ve}$ electrode and a negative ($-^{ve}$) chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating in the $-^{ve}$ chamber of each cell during power delivery containing a sulfide (electrolyte 1), and the electrolyte circulating in the $+^{ve}$ chamber during power delivery containing bromine (electrolyte 2),

(ii) restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers by circulating the electrolyte from each chamber to storage means comprising a volume of electrolyte greater than the cell volume for extended delivery of power over a longer discharge cycle than the cell volume alone would permit, and

(iii) rebalancing the electrolytes by circulating a fraction of electrolyte 1 or electrolyte 2 through the $+^{ve}$ chamber of an auxiliary cell, said auxiliary cell comprising a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell containing water and being free from polysulfide and free from bromine during rebalancing, the auxiliary cell operating so as

to oxidise sulfide ions to sulfur or bromide ions to bromine in the $+^{ve}$ chamber and so as to reduce water to hydrogen and hydroxide ions in the $-^{ve}$ chamber.

2. A process as claimed in claim 1 wherein the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell during rebalancing is a fraction of electrolyte 1 or electrolyte 2 which has been made free of polysulfide or bromine by electrochemical reduction thereof.

3. A process as claimed in claim 2 wherein the electrochemical reduction of polysulfide or bromine is effected by recirculating the fraction of electrolyte 1 or 2 through the $-^{ve}$ chamber of the auxiliary cell until all of the polysulfide or bromine has been reduced.

4. A process as claimed in claim 2 wherein the electrochemical reduction of polysulfide or bromine occurs within the $-^{ve}$ chamber of a second auxiliary cell which comprises a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating through the $+^{ve}$ chamber being a fraction of electrolyte 1 or electrolyte 2.

5. A process as claimed in claim 4 wherein the electrochemical reduction of polysulfide or bromine is effected by recirculating the fraction of electrolyte 1 or 2 through the $-^{ve}$ chamber of the second auxiliary cell until all of the polysulfide or bromine has been reduced.

6. A process as claimed in any one of claims 3 to 5

wherein the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell during rebalancing is a fraction of electrolyte 2 and wherein that fraction is subsequently treated to remove sulfate ions contained therein.

7. A process as claimed in claim 6 wherein said sulfate ions are removed by crystallisation of a sulfate salt from the fraction of electrolyte 2.

8. A process as claimed in any one of claims 2 to 7 wherein the fraction of electrolyte 1 or 2 which is circulated through the $-^{ve}$ chamber of the auxiliary cell is returned to the main stream of electrolyte 1 or 2 respectively.

9. A process as claimed in any one of the preceding claims which additionally comprises adding elemental sulfur and/or a sulfide salt to electrolyte 1 in an amount sufficient to restore the initial concentration of sulfur species.

10. Use, in a process for energy storage and/or power delivery comprising:

(i) maintaining and circulating electrolyte flows in a fully liquid system in which the active constituents are fully soluble in a single cell or in an array of repeating cell structures, each cell with a positive ($+^{ve}$) chamber containing an inert $+^{ve}$ electrode and a negative ($-^{ve}$) chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating in the $-^{ve}$ chamber of each cell during power delivery containing a sulfide (electrolyte 1), and the electrolyte circulating in the $+^{ve}$ chamber during power delivery containing bromine

(electrolyte 2),

(ii) restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers by circulating the electrolyte from each chamber to storage means comprising a volume of electrolyte greater than the cell volume for extended delivery of power over a longer discharge cycle than the cell volume alone would permit,

of a process comprising:

circulating a fraction of electrolyte 1 or electrolyte 2 through the $+^{ve}$ chamber of an auxiliary cell, said auxiliary cell comprising a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one another by a cation exchange membrane, the electrolyte circulating through the $-^{ve}$ chamber of the auxiliary cell containing water and being free from polysulfide and free from bromine during rebalancing, the auxiliary cell operating so as to oxidise sulfide ions to polysulfide or bromide ions to bromine in the $+^{ve}$ chamber and so as to reduce water to hydrogen and hydroxide ions in the $-^{ve}$ chamber,

for the purpose of rebalancing electrolytes 1 and 2.

11. An electrochemical apparatus for energy storage and/or power delivery comprising:

(i) a single cell or an array of repeating cell structures, each cell comprising; a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode the chambers being separated from one another by an ion exchange membrane, an electrolyte circulating in the $-^{ve}$ chamber of each cell which contains a sulfide during power delivery (electrolyte 1), and an electrolyte circulating in the $+^{ve}$ chamber

which contains bromine during power delivery (electrolyte 2),

(ii) storage and circulation means for each electrolyte for restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers,

(iii) means for rebalancing the electrolytes comprising an auxiliary cell which comprises a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode the chambers being separated from one another by a cation exchange membrane, means for circulating a fraction of electrolyte 1 or 2 through the $+^{ve}$ chamber of the auxiliary cell, an electrolyte containing water and being free from polysulfide and free from bromine during rebalancing and means for circulating said electrolyte through the $-^{ve}$ chamber of the auxiliary cell.

12. Apparatus as claimed in claim 11 wherein the means for circulating an electrolyte through the $-^{ve}$ chamber of the auxiliary cell comprises means for circulating a fraction of electrolyte 1 or 2 through the $-^{ve}$ chamber of the auxiliary cell.

13. Apparatus as claimed in claim 11 wherein the means for circulating an electrolyte through the $-^{ve}$ chamber of the auxiliary cell comprises a storage tank into which a fraction of electrolyte 1 or 2 may be transferred and means for re-circulating the fraction of electrolyte 1 or 2 between the $-^{ve}$ chamber of the auxiliary cell and said storage tank.

14. Apparatus as claimed in claim 12 or claim 13 which additionally comprises a second auxiliary cell which comprises a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode, the chambers being separated from one

another by a cation exchange membrane, means for circulating a fraction of electrolyte 1 or 2 through the $+^{ve}$ chamber and means for circulating a fraction of electrolyte 1 or 2 through the $-^{ve}$ chamber.

15. Apparatus as claimed in claim 14 wherein the means for circulating an electrolyte through the $-^{ve}$ chamber of the second auxiliary cell comprises a storage tank into which a fraction of electrolyte 1 or 2 may be transferred and means for re-circulating the fraction of electrolyte 1 or 2 between the $-^{ve}$ chamber of the second auxiliary cell and said storage tank.

16. Apparatus as claimed in any one of claims 12 to 15 wherein the electrolyte circulated through the $-^{ve}$ chamber of the auxiliary cell is electrolyte 2, additionally comprising means for removing sulfate ions from the fraction of electrolyte 2 after circulation through the $-^{ve}$ chamber of the auxiliary cell.

17. Apparatus as claimed in claim 16 wherein the means for removing sulfate ions from electrolyte 2 comprises a crystalliser.

18. Apparatus as claimed in any one of claims 11 to 17 additionally comprising means for passing the fraction of electrolyte 1 or 2 which is circulated through the $-^{ve}$ chamber of the auxiliary cell back to the main stream of electrolyte 1 or 2 respectively.

19. Use in an electrochemical apparatus for energy storage and/or power delivery comprising:

(i) a single cell or an array of repeating cell structures, each cell comprising; a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode the

chambers being separated from one another by an ion exchange membrane, an electrolyte circulating in the $-^{ve}$ chamber of each cell which contains a sulfide during power delivery (electrolyte 1), and an electrolyte circulating in the $+^{ve}$ chamber which contains bromine during power delivery (electrolyte 2), and

(ii) storage and circulation means for each electrolyte for restoring or replenishing the electrolytes in the $+^{ve}$ and $-^{ve}$ chambers,

of

an auxiliary cell which comprises; a $+^{ve}$ chamber containing an inert $+^{ve}$ electrode and a $-^{ve}$ chamber containing an inert $-^{ve}$ electrode the chambers being separated from one another by a cation exchange membrane, means for passing a fraction of electrolyte 1 or 2 through the $+^{ve}$ chamber of the auxiliary cell, an electrolyte containing water and being free from polysulfide and free from bromine during rebalancing and means for circulating said electrolyte through the $-^{ve}$ chamber of the auxiliary cell

for the purpose of rebalancing electrolytes 1 and 2.

1/8

FIG. 1A.

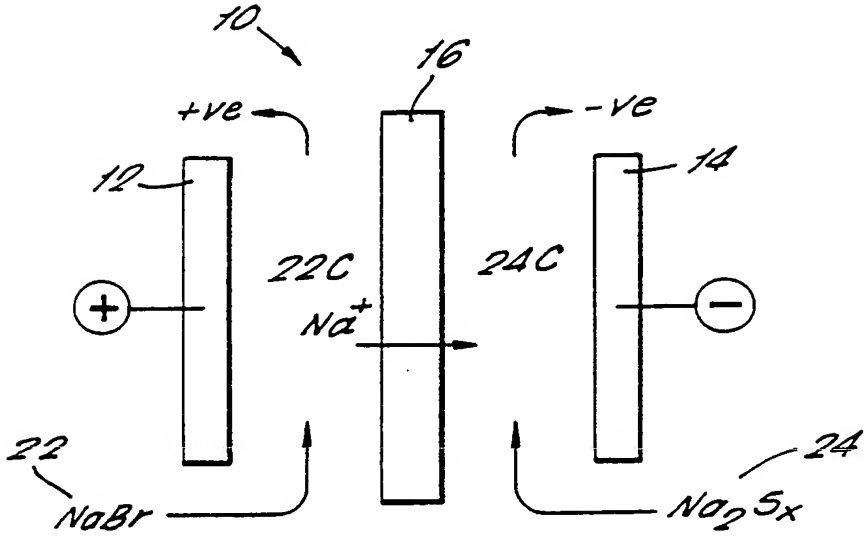


FIG. 1B.

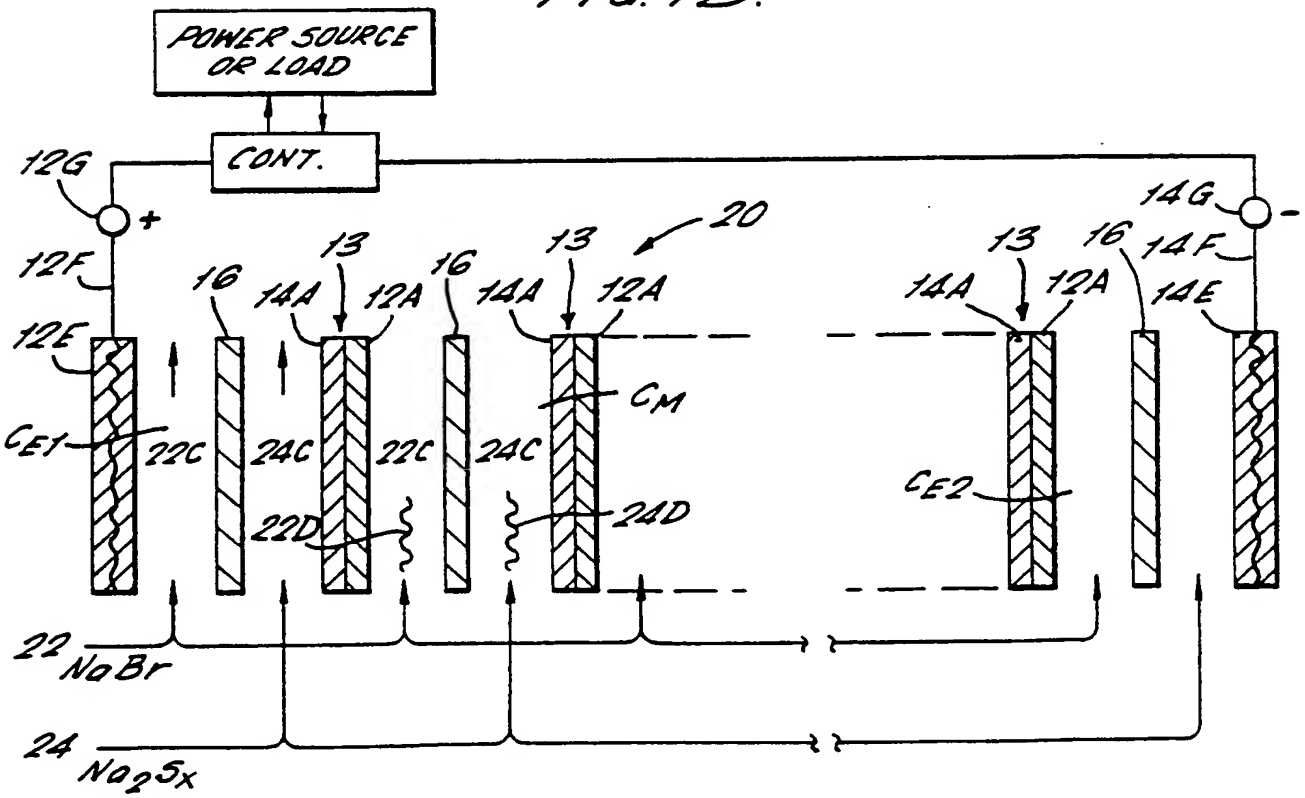
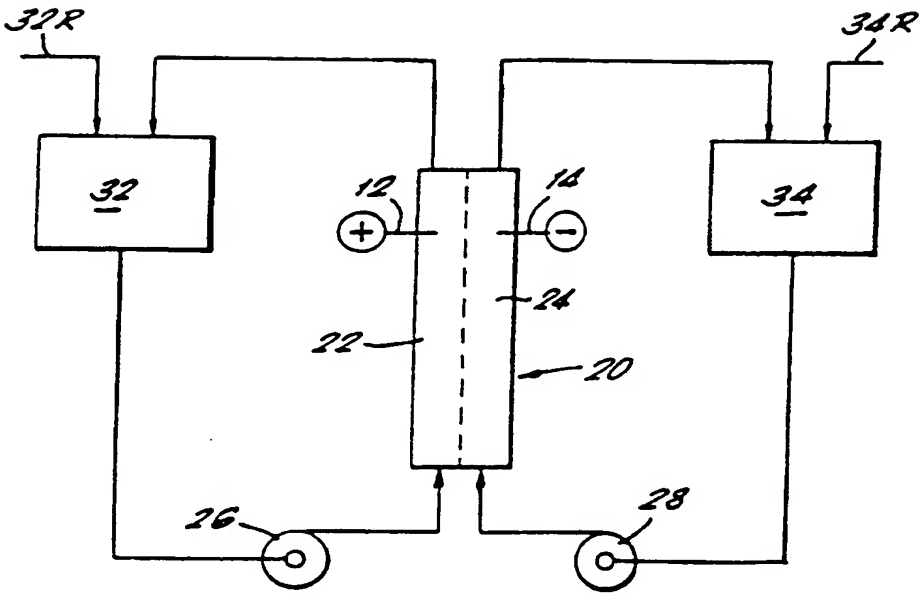


FIG. 2.



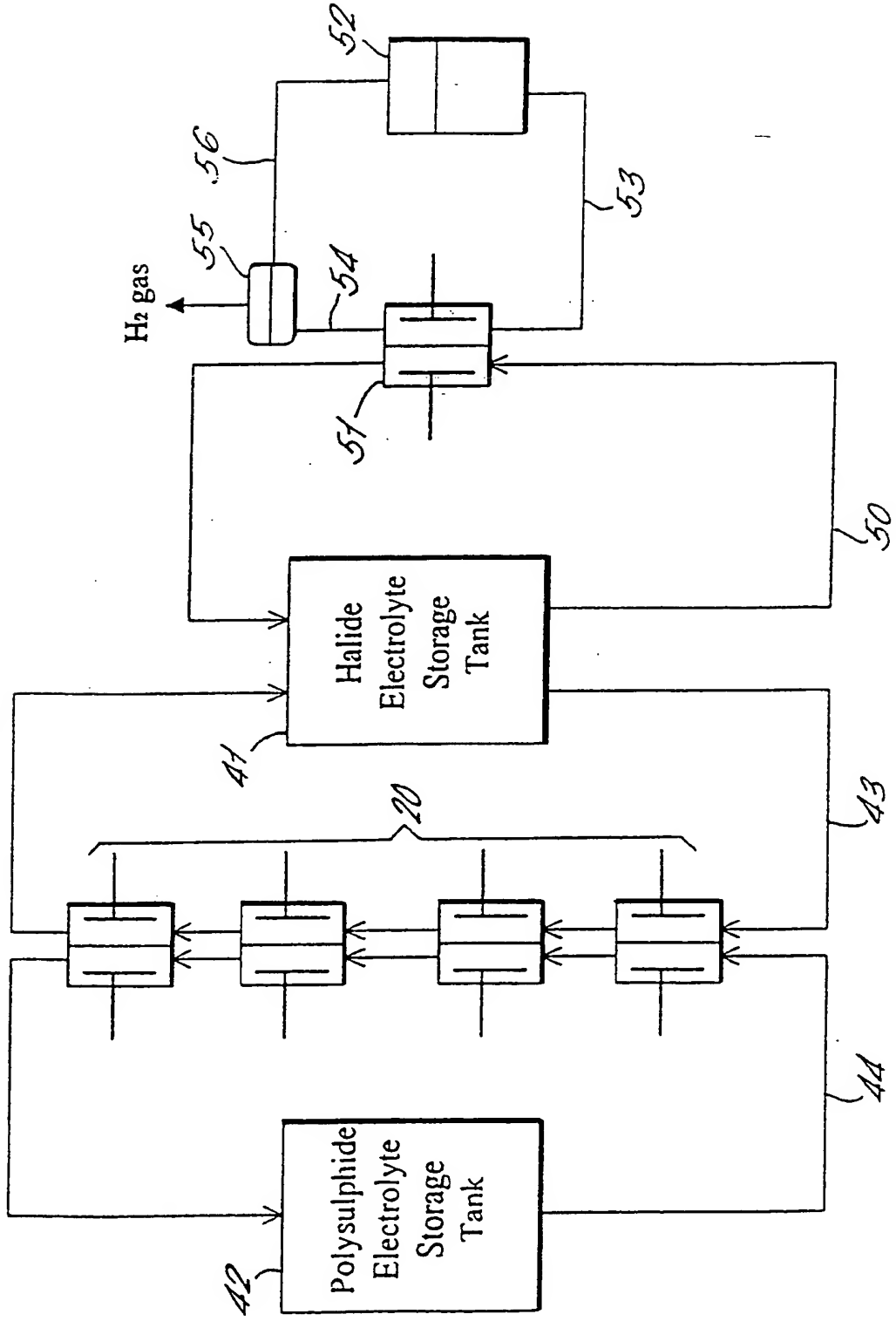

52
56
53
55
54
H2 gas
51
50
Halide Electrolyte Storage Tank
41
20
43
44
Polysulphide Electrolyte Storage Tank
42

FIG. 3.

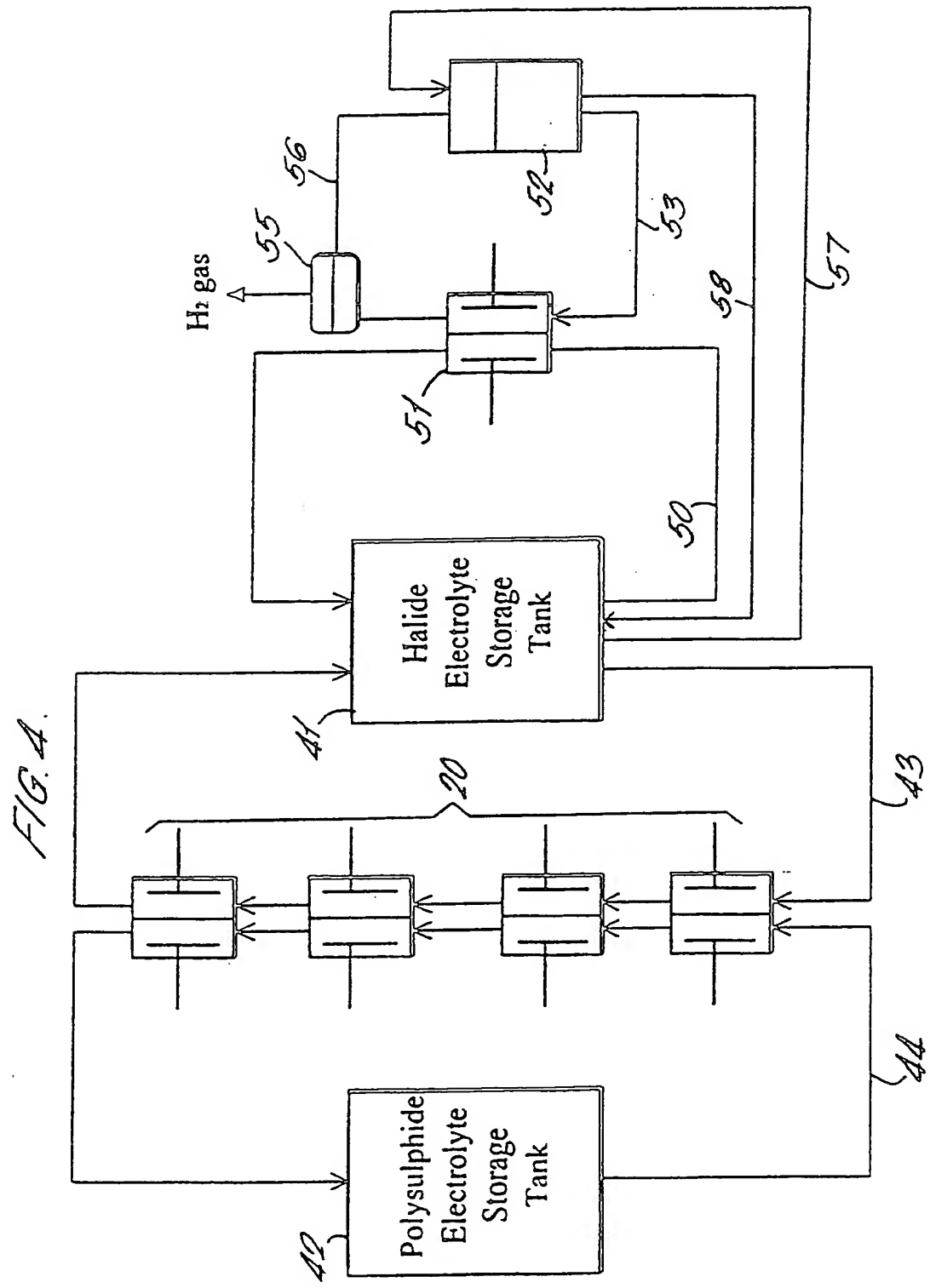

Polysulphide Electrolyte Storage Tank
Halide Electrolyte Storage Tank
H2 gas
10
41
20
43
44
50
51
52
53
55
56
57
58

FIG. 4.

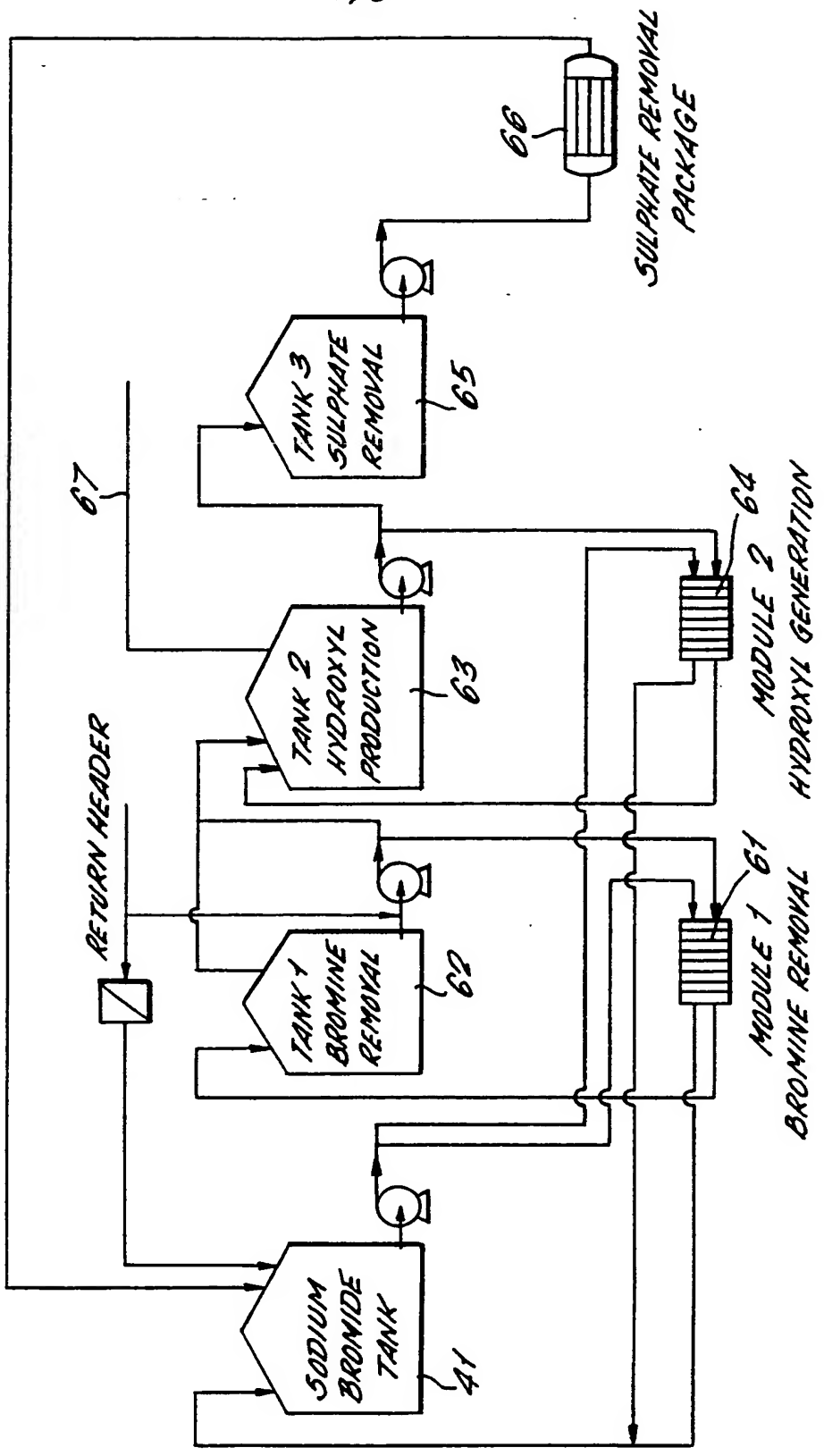
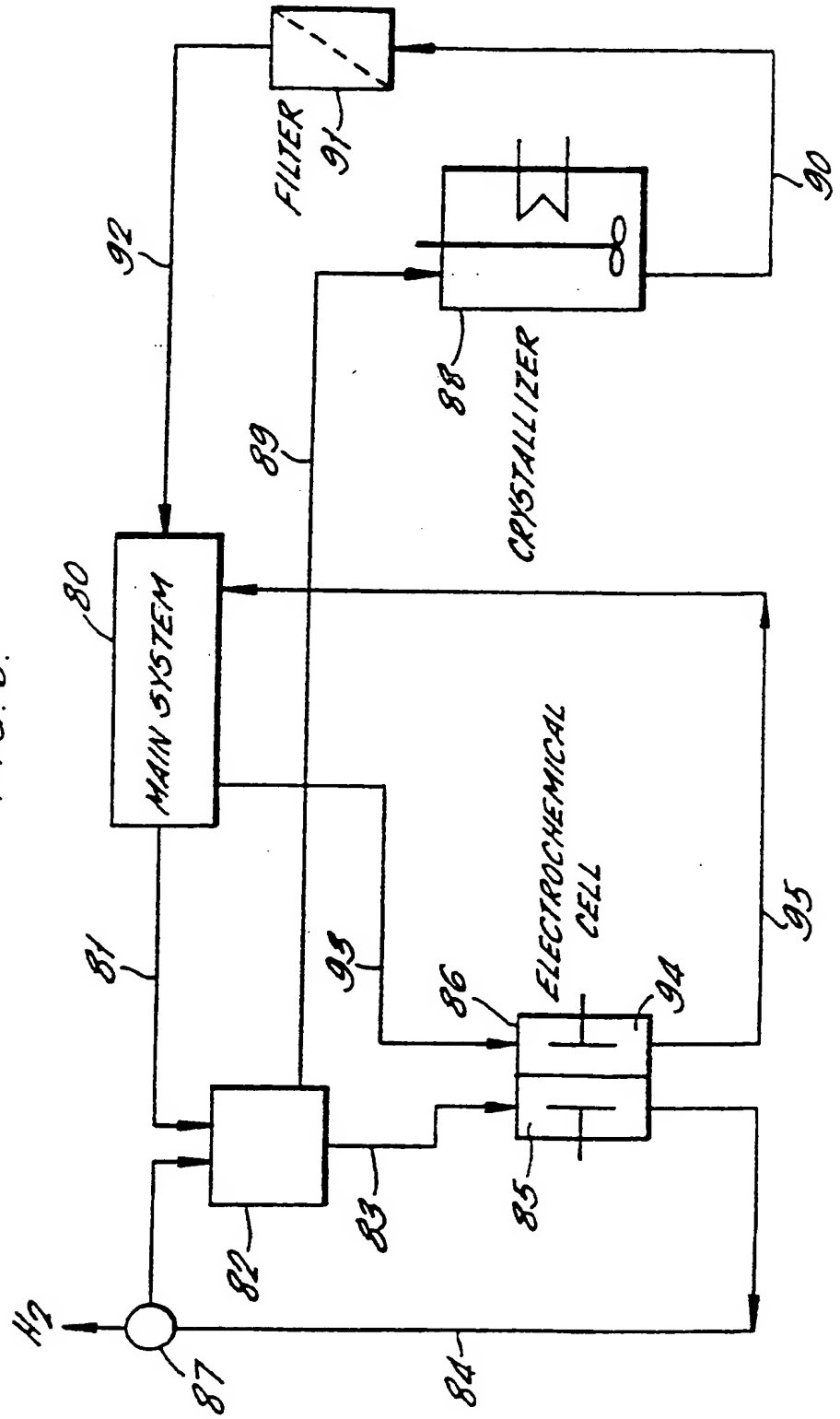

SULPHATE REMOVAL PACKAGE
66
TANK 3 SULPHATE REMOVAL
65
67
TANK 2 HYDROXYL PRODUCTION
63
MODULE 2 HYDROXYL GENERATION
64
RETURN HEADER
TANK 1 BROMINE REMOVAL
60
MODULE 1 BROMINE REMOVAL
61
SODIUM BROMIDE TANK
41

FIG. 5.


FILTER
91
90
92
88
CRYSTALLIZER
89
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MAIN SYSTEM
ELECTROCHEMICAL CELL
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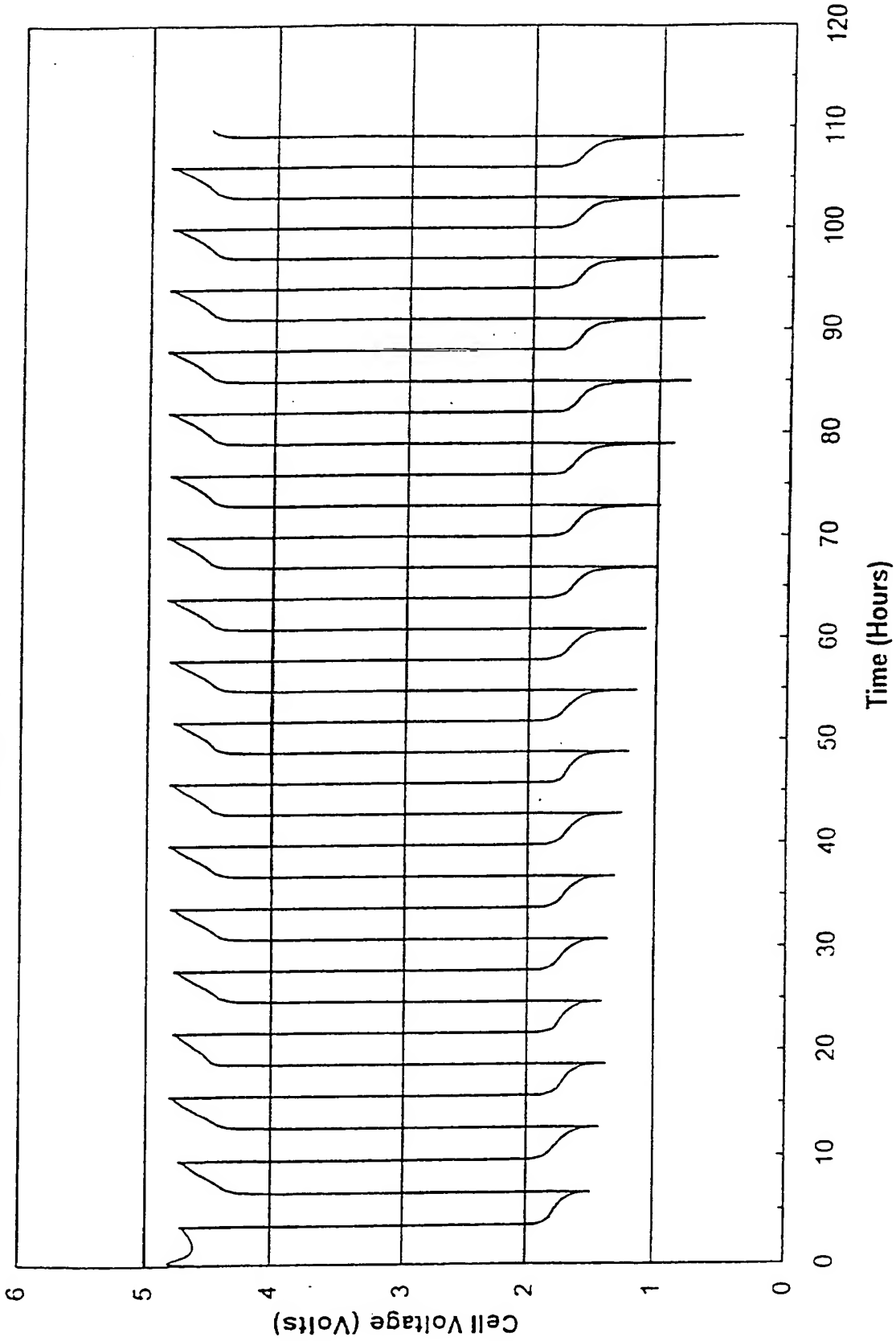
93
86
94
95
85
83
82
H2
87
84

FIG. 6.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0
1
2
3
4
5
6
Time (Hours)
0
10
20
30
40
50
60
70
80
90
100
110
120

FIG. 7.

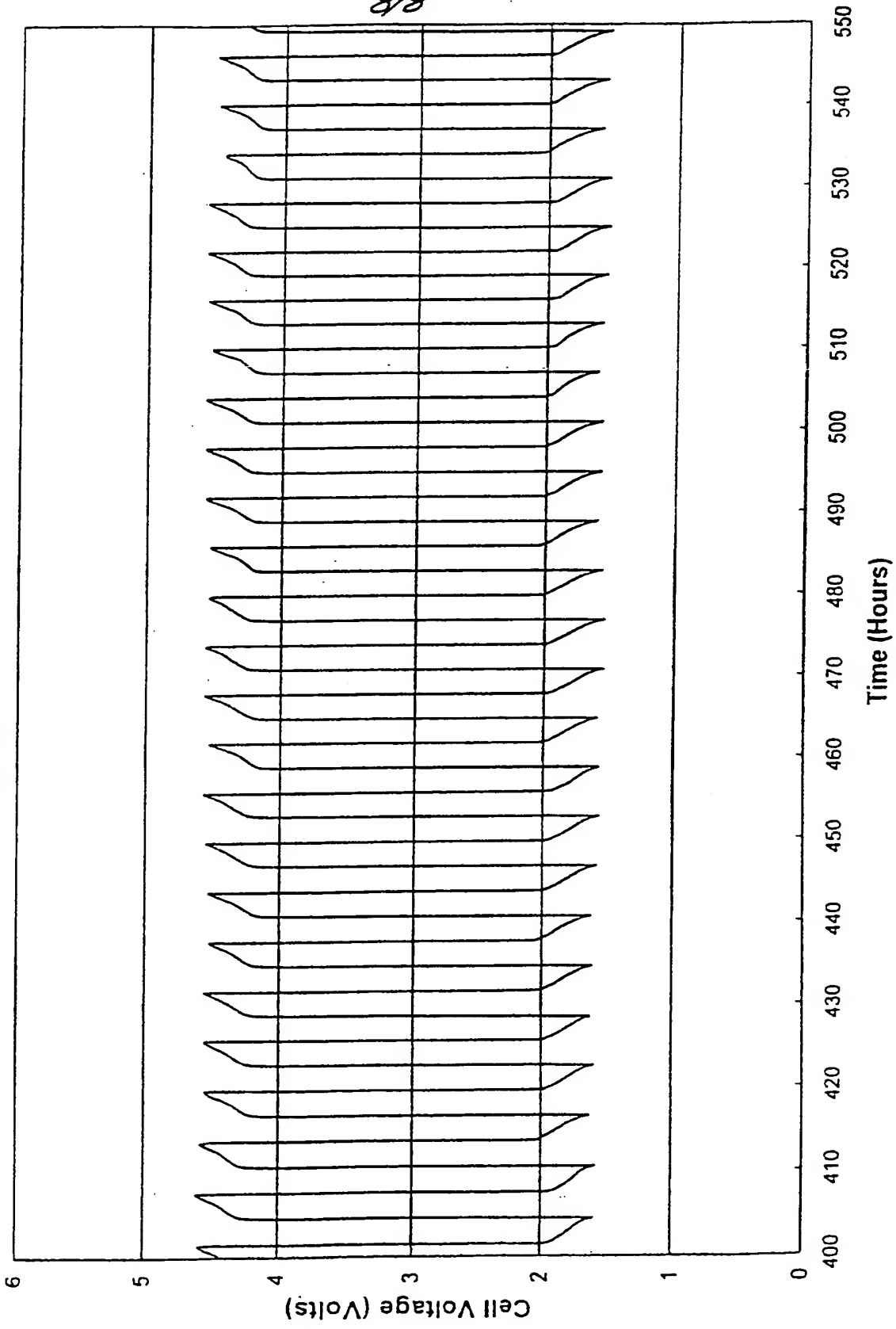
Cell Voltage (Volts)
0
1
2
3
4
5
6
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
Time (Hours)

FIG 8.

INTERNATIONAL SEARCH REPORT

Internal Application No
GB 00/02536

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M8/04 H01M8/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal, CHEM ABS Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 09522 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1-3,6,7,9,10 page 15, line 15 -page 16, line 31; figure 3A page 18, line 16 - line 35 page 25, line 19 -page 26, line 14 ---	1-19
A	US 5 612 148 A (ZITO RALPH) 18 March 1997 (1997-03-18) column 3, line 66 -column 4, line 27 column 7, line 21 - line 45; claims 1,2,8,10; figure 2 ---	1-19
A	WO 94 09526 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1,5,6,8,10 page 11, line 1 - line 29; figure 1E --- -/--	1-19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 2000	24/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Battistig, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Interna[illegible]nal Application No
[illegible]/GB 00/02536

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 09525 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1-9	1-19
A	DE 35 22 714 A (FRAUNHOFER GES FORSCHUNG) 8 January 1987 (1987-01-08) claims 1,3,7	1-19

1

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		DE 69316387 T	28-05-1998
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		DE 69316387 T	28-05-1998
		DK 664931 T	08-12-1997
		DK 664932 T	14-09-1998
		EG 20201 A	30-10-1997
		EP 0664931 A	02-08-1995
		EP 0664932 A	02-08-1995
		ES 2104179 T	01-10-1997
		ES 2111774 T	16-03-1998
		WO 9409526 A	28-04-1994
		GR 3024385 T	28-11-1997
		GR 3026051 T	29-05-1998
		HK 1007461 A	09-04-1999
		IL 107237 A	14-05-1996
		JP 8502387 T	12-03-1996
		JP 8502388 T	12-03-1996
		US 5496659 A	05-03-1996
		ZA 9307284 A	30-03-1995
		US 5422197 A	06-06-1995
DE 3522714 A	08-01-1987	NONE	

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* SJA/53278/00 6

Box No. I TITLE OF INVENTION

ELECTROLYTE REBALANCING SYSTEM

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

NATIONAL POWER PLC
Windmill Hill Business Park
Whitehill Way
Swindon, Wiltshire
SN5 6PB
United Kingdom

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: United Kingdom

State *(that is, country)* of residence: United Kingdom

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

MORRISSEY; Patrick John
11 Bryong Close
Hillingdon
Middlesex
UB8 3RB
United Kingdom

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: Ireland

State *(that is, country)* of residence: Unbited Kingdom

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BOULT WADE TENNANT
VERULAM GARDENS
70 GRAY'S INN ROAD
LONDON WC1X 8BT
UNITED KINGDOM

Telephone No. +44 (0)20 7430 7500

Facsimile No. +44 (0)20 7831 1768

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*
MITCHELL; Philip John
1 Compton Close
Loughborough
LE1 13SF
United Kingdom

This person is:
☐ applicant only
☒ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: United Kingdom

State *(that is, country)* of residence: United Kingdom

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*
MALE; Stewart Ernest
68 Farm Close
East Grinstead
West Susex
RH19 3QG
United Kingdoim

This person is:
☐ applicant only
☒ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: United Kingdom

State *(that is, country)* of residence: United Kingdom

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
☐ applicant only
☐ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
☐ applicant only
☐ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

☒ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **TZ** United Republic of Tanzania, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☒ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☒ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

☒ **AE** United Arab Emirates
☒ **AL** Albania
☒ **AM** Armenia
☒ **AT** Austria
☒ **AU** Australia
☒ **AZ** Azerbaijan
☒ **BA** Bosnia and Herzegovina
☒ **BB** Barbados
☒ **BG** Bulgaria
☒ **BR** Brazil
☒ **BY** Belarus
☒ **CA** Canada
☒ **CH and LI** Switzerland and Liechtenstein
☒ **CN** China
☒ **CR** Costa Rica
☒ **CU** Cuba
☒ **CZ** Czech Republic
☒ **DE** Germany
☒ **DK** Denmark
☒ **DM** Dominica
☒ **EE** Estonia
☒ **ES** Spain
☒ **FI** Finland
☒ **GB** United Kingdom
☒ **GD** Grenada
☒ **GE** Georgia
☒ **GH** Ghana
☒ **GM** Gambia
☒ **HR** Croatia
☒ **HU** Hungary
☒ **ID** Indonesia
☒ **IL** Israel
☒ **IN** India
☒ **IS** Iceland
☒ **JP** Japan
☒ **KE** Kenya
☒ **KG** Kyrgyzstan
☒ **KP** Democratic People's Republic of Korea
☒ **KR** Republic of Korea
☒ **KZ** Kazakhstan
☒ **LC** Saint Lucia
☒ **LK** Sri Lanka
☒ **LR** Liberia
☒ **LS** Lesotho
☒ **LT** Lithuania
☒ **LU** Luxembourg
☒ **LV** Latvia
☒ **MA** Morocco
☒ **MD** Republic of Moldova
☒ **MG** Madagascar
☒ **MK** The former Yugoslav Republic of Macedonia
☒ **MN** Mongolia
☒ **MW** Malawi
☒ **MX** Mexico
☒ **NO** Norway
☒ **NZ** New Zealand
☒ **PL** Poland
☒ **PT** Portugal
☒ **RO** Romania
☒ **RU** Russian Federation
☒ **SD** Sudan
☒ **SE** Sweden
☒ **SG** Singapore
☒ **SI** Slovenia
☒ **SK** Slovakia
☒ **SL** Sierra Leone
☒ **TJ** Tajikistan
☒ **TM** Turkmenistan
☒ **TR** Turkey
☒ **TT** Trinidad and Tobago
☒ **TZ** United Republic of Tanzania
☒ **UA** Ukraine
☒ **UG** Uganda
☒ **US** United States of America
☒ **UZ** Uzbekistan
☒ **VN** Viet Nam
☒ **YU** Yugoslavia
☒ **ZA** South Africa
☒ **ZW** Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

☒ AG Antigua & Barbuda ☒ BZ Belize ☒ DO Dominican Republic
☒ DZ Algeria ☒ MZ Mozambique

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 02/07/1999	PCT/GB99/02103	GB		
item (2) 30/11/1999	9928344.2	GB		
item (3)				

☐ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): _____

** Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)* :

ISA /

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request	: 4
description (excluding sequence listing part)	: 21
claims	: 7
abstract	: 1
drawings	: 8
sequence listing part of description	:
Total number of sheets	: 41

This international application is **accompanied by** the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☐ other *(specify)*:

Figure of the drawings which should accompany the abstract:

Language of filing of the international application: ENGLISH

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

ALLARD; Susan Joyce
BOULT WADE TENNANT

30th June, 2000

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA /
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

PATENT COOPERATION TREATY

Miss Allard (cwlu)
HCC - 8/5/01
NAT. PHASE - 2/1/02

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

BOULT WADE TENNANT
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT
GRANDE BRETAGNE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)* 04.05.2001	
Applicant's or agent's file reference SJA/53278/006	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02536	30/06/2000	02/07/1999

Applicant
NATIONAL POWER PLC et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Myers, J Tel.+49 89 2399-8111

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
SJA/53278/006		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02536	30/06/2000	02/07/1999
International Patent Classification (IPC) or national classification and IPC H01M8/04		
Applicant NATIONAL POWER PLC et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/01/2001	04.05.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fitzpatrick, J Telephone No. +49 89 2399 8570

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02536

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-21 as originally filed

Claims, No.:

1-19 as originally filed

Drawings, sheets:

1/8-8/8 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-19
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-19
	No:	Claims	

2. Citations and explanations
   see separate sheet

Section V.2: Citations and Explanations

D1 = WO 94 09522
D2 = US 5 612 148

With particular respect to the specific passages cited in the International Search Report (ISR), although documents D1 and D2 respectively use external electrochemical cells for the oxidation of halide and sulfide or bisulfide, neither these nor the remaining documents of the ISR anticipate or fairly suggest the method of rebalancing the electrolytes of part (iii) of current claim 1. Moreover, none of the cell systems of the prior art would be suitable for carrying out said method. In particular, taking document D1 as closest state of the art, on the basis of it's disclosure, the **genuine apparatus** features of current main claim 11 are distinguished over that of Fig.3A in combination with Fig. 3B or 3C of D1 via:

- the cation exchange membrane of the auxiliary cell.
- the means for circulating an electrolyte through the -ve chamber of the auxiliary cell
- the provision of means for **alternatively** circulating electrolyte 1 or 2 through the +ve chamber of the auxiliary cell.

These all contribute to ensuring added versatility as well as improved electrolyte re-balancing over the prior art whilst minimising the undesirable reduction of polysulfide to sulfide and oxidation of polysulphide/sulfide to "lost" sulphate. This ensures that the requirements of Art.33(3) PCT are also fulfilled.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

To:
BOULT WADE TENNANT
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT
UNITED KINGDOM

Miss Allard/ocw
26/10/00
Exam 2/2/01
In Diary UB 26/10

Date of mailing *(day/month/year)*	24/10/2000
Applicant's or agent's file reference: SJA/53278/006	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No.: PCT/GB 00/ 02536	International filing date *(day/month/year)* 30/06/2000
Applicant: NATIONAL POWER PLC et al.	

1. [X] The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

RECEIVED
25 OCT 2000
BOULT WADE TENNANT

2. [ ] The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

[ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Maria Van der Hoeven

Form PCT/ISA/220 (July 1998)

N TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

BNSDOCID: <XSISA220NOENP4_I_>

NOTES TO FORM PCT/ISA/220 (c ntln

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped),whether

(i) the claim is unchanged;

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international appplication is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

BNSDOCID: <XSISA220NOENP4_I_>

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
SJA/53278/006		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02536	30/06/2000	02/07/1999
Applicant		
NATIONAL POWER PLC et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

[ ] as suggested by the applicant.

[X] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]T/GB 00/02536

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M8/04 H01M8/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal, CHEM ABS Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 09522 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1-3,6,7,9,10 page 15, line 15 -page 16, line 31; figure 3A page 18, line 16 - line 35 page 25, line 19 -page 26, line 14 ---	1-19
A	US 5 612 148 A (ZITO RALPH) 18 March 1997 (1997-03-18) column 3, line 66 -column 4, line 27 column 7, line 21 - line 45; claims 1,2,8,10; figure 2 ---	1-19
A	WO 94 09526 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1,5,6,8,10 page 11, line 1 - line 29; figure 1E --- -/--	1-19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 2000	24/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Battistig, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02536

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 09525 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1-9	1-19
A	DE 35 22 714 A (FRAUNHOFER GES FORSCHUNG) 8 January 1987 (1987-01-08) claims 1,3,7	1-19

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02536

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9409522 A	28-04-1994	AT 139372 T	15-06-1996
		AU 671863 B	12-09-1996
		AU 5153593 A	09-05-1994
		BG 61627 B	30-01-1998
		BG 99562 A	30-11-1995
		BR 9307234 A	13-10-1999
		CA 2145883 A	28-04-1994
		CN 1087753 A,B	08-06-1994
		CZ 9500954 A	16-08-1995
		DE 69303179 D	18-07-1996
		DE 69303179 T	10-10-1996
		DK 664929 T	28-10-1996
		EG 20194 A	30-10-1997
		EP 0664929 A	02-08-1995
		ES 2089853 T	01-10-1996
		FI 951815 A	13-06-1995
		GR 3020714 T	30-11-1996
		HK 1001071 A	22-05-1998
		HU 72141 A,B	28-03-1996
		IL 107236 A	31-12-1995
		JP 8502385 T	12-03-1996
		NO 951377 A	07-04-1995
		NZ 256709 A	27-11-1995
		PL 308266 A	24-07-1995
		RU 2110118 C	27-04-1998
		SG 52426 A	28-09-1998
		SK 48195 A	13-09-1995
		US 5439757 A	08-08-1995
		ZA 9307283 A	30-03-1995
US 5612148 A	18-03-1997	NONE	
WO 9409526 A	28-04-1994	AT 152860 T	15-05-1997
		AT 162338 T	15-01-1998
		AU 672049 B	19-09-1996
		AU 5153793 A	09-05-1994
		AU 676691 B	20-03-1997
		AU 5153893 A	09-05-1994
		CN 1087752 A,B	08-06-1994
		DE 69310529 D	12-06-1997
		DE 69310529 T	06-11-1997
		DE 69316387 D	19-02-1998
		DE 69316387 T	28-05-1998
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		DK 664932 T	14-09-1998
		EG 20201 A	30-10-1997
		EP 0664931 A	02-08-1995
		EP 0664932 A	02-08-1995
		ES 2104179 T	01-10-1997
		ES 2111774 T	16-03-1998
		WO 9409525 A	28-04-1994
		GR 3024385 T	28-11-1997
		GR 3026051 T	29-05-1998
		HK 1007461 A	09-04-1999
		IL 107237 A	14-05-1996
		JP 8502387 T	12-03-1996
		JP 8502388 T	12-03-1996
		US 5496659 A	05-03-1996

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02536

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9409526 A		ZA 9307284 A	30-03-1995
WO 9409525 A	28-04-1994	AT 152860 T	15-05-1997
		AT 162338 T	15-01-1998
		AU 672049 B	19-09-1996
		AU 5153793 A	09-05-1994
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		DE 69310529 T	06-11-1997
		DE 69316387 D	19-02-1998
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		DK 664931 T	08-12-1997
		DK 664932 T	14-09-1998
		EG 20201 A	30-10-1997
		EP 0664931 A	02-08-1995
		EP 0664932 A	02-08-1995
		ES 2104179 T	01-10-1997
		ES 2111774 T	16-03-1998
		WO 9409526 A	28-04-1994
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		GR 3026051 T	29-05-1998
		HK 1007461 A	09-04-1999
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		JP 8502387 T	12-03-1996
		JP 8502388 T	12-03-1996
		US 5496659 A	05-03-1996
		ZA 9307284 A	30-03-1995
		US 5422197 A	06-06-1995
DE 3522714 A	08-01-1987	NONE	

PATENT COOPERATION TREATY

RECD 08 MAY 2001
WIPO PCT

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
SJA/53278/006		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02536	30/06/2000	02/07/1999
International Patent Classification (IPC) or national classification and IPC H01M8/04		
Applicant NATIONAL POWER PLC et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/01/2001	04.05.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fitzpatrick, J Telephone No. +49 89 2399 8570

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02536

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-21 as originally filed

Claims, No.:

1-19 as originally filed

Drawings, sheets:

1/8-8/8 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-19
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-19
	No:	Claims	

2. Citations and explanations
   see separate sheet

Section V.2: Citations and Explanations

D1 = WO 94 09522
D2 = US 5 612 148

With particular respect to the specific passages cited in the International Search Report (ISR), although documents D1 and D2 respectively use external electrochemical cells for the oxidation of halide and sulfide or bisulfide, neither these nor the remaining documents of the ISR anticipate or fairly suggest the method of rebalancing the electrolytes of part (iii) of current claim 1. Moreover, none of the cell systems of the prior art would be suitable for carrying out said method. In particular, taking document D1 as closest state of the art, on the basis of it's disclosure, the **genuine apparatus** features of current main claim 11 are distinguished over that of Fig.3A in combination with Fig. 3B or 3C of D1 via:

- the cation exchange membrane of the auxiliary cell.
- the means for circulating an electrolyte through the -ve chamber of the auxiliary cell
- the provision of means for **alternatively** circulating electrolyte 1 or 2 through the +ve chamber of the auxiliary cell.

These all contribute to ensuring added versatility as well as improved electrolyte re-balancing over the prior art whilst minimising the undesirable reduction of polysulfide to sulfide and oxidation of polysulphide/sulfide to "lost" sulphate. This ensures that the requirements of Art.33(3) PCT are also fulfilled.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
SJA/53278/006		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02536	30/06/2000	02/07/1999
Applicant		
NATIONAL POWER PLC et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

   [ ] as suggested by the applicant.

   [X] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
T/GB 00/02536

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M8/04 H01M8/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal, CHEM ABS Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 09522 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1-3,6,7,9,10 page 15, line 15 -page 16, line 31; figure 3A page 18, line 16 - line 35 page 25, line 19 -page 26, line 14 ---	1-19
A	US 5 612 148 A (ZITO RALPH) 18 March 1997 (1997-03-18) column 3, line 66 -column 4, line 27 column 7, line 21 - line 45; claims 1,2,8,10; figure 2 ---	1-19
A	WO 94 09526 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1,5,6,8,10 page 11, line 1 - line 29; figure 1E --- -/--	1-19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 2000	24/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Battistig, M

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]T/GB 00/02536

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 09525 A (NAT POWER PLC ;ZITO RALPH (US)) 28 April 1994 (1994-04-28) claims 1-9 ---	1-19
A	DE 35 22 714 A (FRAUNHOFER GES FORSCHUNG) 8 January 1987 (1987-01-08) claims 1,3,7 -----	1-19

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
T/GB 00/02536

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9409522 A	28-04-1994	AT 139372 T	15-06-1996
		AU 671863 B	12-09-1996
		AU 5153593 A	09-05-1994
		BG 61627 B	30-01-1998
		BG 99562 A	30-11-1995
		BR 9307234 A	13-10-1999
		CA 2145883 A	28-04-1994
		CN 1087753 A,B	08-06-1994
		CZ 9500954 A	16-08-1995
		DE 69303179 D	18-07-1996
		DE 69303179 T	10-10-1996
		DK 664929 T	28-10-1996
		EG 20194 A	30-10-1997
		EP 0664929 A	02-08-1995
		ES 2089853 T	01-10-1996
		FI 951815 A	13-06-1995
		GR 3020714 T	30-11-1996
		HK 1001071 A	22-05-1998
		HU 72141 A,B	28-03-1996
		IL 107236 A	31-12-1995
		JP 8502385 T	12-03-1996
		NO 951377 A	07-04-1995
		NZ 256709 A	27-11-1995
		PL 308266 A	24-07-1995
		RU 2110118 C	27-04-1998
		SG 52426 A	28-09-1998
		SK 48195 A	13-09-1995
		US 5439757 A	08-08-1995
		ZA 9307283 A	30-03-1995
US 5612148 A	18-03-1997	NONE	
WO 9409526 A	28-04-1994	AT 152860 T	15-05-1997
		AT 162338 T	15-01-1998
		AU 672049 B	19-09-1996
		AU 5153793 A	09-05-1994
		AU 676691 B	20-03-1997
		AU 5153893 A	09-05-1994
		CN 1087752 A,B	08-06-1994
		DE 69310529 D	12-06-1997
		DE 69310529 T	06-11-1997
		DE 69316387 D	19-02-1998
		DE 69316387 T	28-05-1998
		DK 664931 T	08-12-1997
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